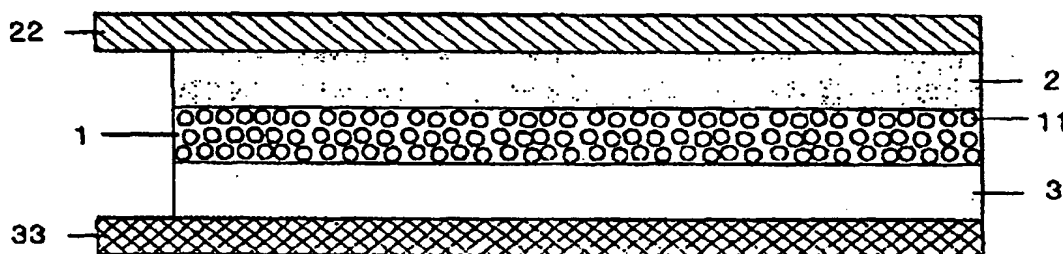




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(54) Title: MICROPOROUS SOLID ELECTROLYTES AND METHODS FOR PREPARING THEM

**(57) Abstract**

The present invention relates to a solid electrolyte having a good conductivity to lithium ion by allowing the liquid components and lithium salts to be absorbed into the electrolyte film containing an absorbent added at the time of its preparation and having a porosity, a process for preparing the same and a rechargeable lithium cell using the same as an electrolyte. As the absorbent, inorganic materials having not more than 40 μm of particle size can be used. As the polymer binder, any binder of whom solubility against the liquid electrolyte is small can be used. A wet process can introduce the porous structure of the electrolyte film. The solid electrolyte according to the present invention has the ionic conductivity of more than approximately 1 to 3×10^{-3} S/cm at room temperature and low reactivity to lithium metal. The cell is fabricated from the solid electrolyte together with electrodes by lamination or pressing methods and, the liquid electrolyte, which is decomposed by moisture, is introduced to a cell just before packaging. Therefore, the solid electrolyte according to the present invention is not affected by the humidity and temperature conditions during the manufacturing of the electrolyte film. In addition, the solid electrolyte according to the present invention has high thermal, mechanical and electrochemical stability, and thus is suitable as an electrolyte for rechargeable lithium cells.

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MICROPOROUS SOLID ELECTROLYTES AND METHODS FOR PREPARING THEM

5 Technical Field

The present invention relates to an electrolyte film usable in rechargeable cells. More particularly, it relates to a provision of pathways for ions mobile between a cathode and an anode during
10 repeated charge and discharge of rechargeable cells by introducing liquid components and lithium salts (hereinafter, both are referred to as "liquid electrolytes") to an electrolyte film having microporous structures and containing an absorbent.

15 Electrochemical cells include three essential components, i.e., cathode, anode and electrolyte. Examples of materials for said anode are typically compounds in which lithium metal or lithium ions can be intercalated, preferably carbon and polymer materials. Examples of materials for said cathode are typically materials in which lithium ions
20 can be intercalated. For example, oxide compounds or polymer materials such as lithium cobalt oxide (Li_xCoO_2), lithium nickel oxide (Li_xNiO_2), lithium nickel cobalt oxide ($\text{Li}_x\text{Ni}_y\text{Co}_{1-y}\text{O}_2$), spinel type lithium manganese oxide ($\text{Li}_x\text{Mn}_2\text{O}_4$) and manganese dioxide (MnO_2) can be used. The introduction of a liquid electrolyte to said electrolyte
25 film can lead to the formation of an ion conductive matrix.

Background Art

Electrochemical cells using polymer electrolytes have some
5 advantages over ones using liquid electrolytes in that i) they have less leakage risk of liquid; ii) they have excellent electrochemical stability, which makes it possible to manufacture various types of cells; and iii) they make the automation of the manufacturing process easy.

10 Since the fact that polymers such as polyoxyethylene may have metal ionic conductivity in case that they contain polar heterologous atoms capable of electric interaction with metal ions was found, research on ion conductive polymers, i.e., polymer electrolytes has been actively conducted. However, since pure polymers such as
15 polyoxyethylene have very low ionic conductivity of 10^{-8} S/cm or so at room temperature, they have a demerit in that they should be approached to the temperature of approximately 100°C in order to show ionic conductivity of approximately 10^{-4} S/cm applicable to electrochemical cells. For this reason, the main stream of the research
20 on polymer electrolytes was concentrated on the improvement of conductivity.

As the fact that the conduction of ion in polymer electrolytes requires transfer of polymer chains was found, attempts to improve
25 conductivity of ions have been carried out in a direction of increasing the flexibility of polymer chains. Blonsky *et al* proposed a method for manufacturing an electrolyte having increased conductivity of 10^{-5}

S/cm by introducing phosphazene linkages to the main chain of the polymers (*J. Am. Chem. Soc.*, 106, 6854 (1984)). However, said electrolyte has lower conductivity and poor mechanical strength.

5 Alternatively, in order to decrease the crystallinity of polymers, various attempts such as modifying the structure of polymers or adding inorganic materials to polymers have been conducted. However, pure polymer electrolytes consisting of polymers and metal salts (not containing liquid electrolytes) still do not exhibit sufficient
10 conductivity.

 On the contrary, gel-type electrolytes disclosed in US Patent 5,219,679 contain liquid electrolytes in their polymer backbones, and thus demonstrate conductivity close to that of liquid electrolytes while
15 exhibiting properties of polymers in their mechanical properties, suggesting the possibility of commercialization to rechargeable battery. Namely, the cell of said patent doesn't need a separate activation procedure of adding a liquid electrolyte, but contains some amount of liquid electrolytes which were incorporated during the manufacture of
20 the polymer electrolytes (a mixture of polymer solution and liquid electrolyte was subjected to casting). However, the electrolytes in the US Patent No. 5,219,679 have problems in that they contain polymers such as polyacrylonitrile which are reactive to lithium metal, and thus the reaction products between electrolytes and lithium electrode come
25 to be accumulated during the storage and use period of the cell, resulting in a constant increase in interfacial resistance.

Meanwhile, Scrosati *et al* manufactured gel-type polymer electrolytes using polymethylmethacrylate having low reactivity with lithium metal (*Electrochim. Acta*, 140, 991 (1995)). These electrolytes which use polymethylmethacrylate as a polymer component have little reactivity with the surface of lithium, and thus have a merit in that the resistance increase phenomenon on the surface of electrode during the storage is insignificant. However, they also have demerits in that they have poor mechanical strength and thus the content of the polymers should be increased to accomplish strength sufficient to form a film, which in turn decreases the conductivity down to 10^{-4} S/cm. In addition, since the gel-type electrolytes contain a large amount of liquid components, it is inevitable that the evaporation of the liquid components on the surface of the electrolytes will occur. For this reason, there have been some risks of causing composition changes due to the loss of liquid components during the storage, which leads to the decrease in conductivity. In addition, this method has a demerit of necessitating a dehumidifying atmosphere wherein moisture is removed to the utmost since lithium salts contained in the liquid electrolytes react and decompose with moisture in the air.

US Patent Nos. 5,296,318 and 5,418,091 proposed a hybrid polymer electrolyte system to compensate for the said problems. This hybrid polymer electrolyte can minimize the moisture effect on the process of manufacturing electrolytes by adding the liquid electrolytes susceptible to the effect of moisture prior to the packaging of battery, while taking advantage of the merits of gel-type polymer electrolytes (the gel-type polymer electrolytes contain a large amount of liquid

electrolytes and thus the conduction of lithium ion proceeds via liquid phase, thereby having similar conductivity to that of liquid electrolytes). However, since the liquid electrolytes are added after electrolyte film is prepared, it is necessary for the inside of the electrolyte film to have sites capable of absorbing liquid components therein or driving force making the liquid component possible to be penetrated thereinto. To this end, dibutyl phthalate is added as a plasticizer in the step of preparing electrolyte film, and after the assembly of cell is complete, the plasticizer is extracted by the use of an organic solvent such as alcohol or ether to form sites for liquid component being absorbed. However, due to the procedure of extracting dibutyl phthalate utilizing a chemical reaction, the methods have fatal demerits that the reproducibility is low, the manufacturing yield is reduced, and the automation for mass production is difficult.

Accordingly, the present inventors in Korean Patent Application No. 98-57030 tried to solve the above-mentioned problems of said prior art by means of adding an absorbent capable of absorbing liquid electrolytes to a polymer matrix to form a solid electrolyte film, and after the assembly of the battery, introducing a liquid electrolyte to the activation procedure of the battery.

The electrolyte film of the said solid electrolyte consists of an absorbent and a polymer binder under dried condition. The polymer binder has more or less dense structure. In order to show more excellent lithium ionic conductivity by improving the absorption ability



of a liquid electrolyte, the solid electrolyte of which the stereo structure of the electrolyte film is changed is need.

Disclosure of Invention

5

Accordingly, the present invention desires to solve the above mentioned problems encountered in the process for the preparation of a solid electrolyte which comprise of adding an absorbent capable of absorbing liquid electrolytes to a polymer matrix to form an electrolyte
10 film, and after the assembly of the battery. Namely, the present invention introduces microporous structures to the polymer matrix while maintaining the mechanical strength of the electrolyte film as it is, which facilitates the absorption of the liquid electrolyte, which in turn improves the lithium ionic conductivity of the solid electrolyte.

15

The term "electrolyte film" used in the specification refers to an electrolyte film which is dried condition and does not contain any liquid electrolytes. The term "solid electrolytes" used in the specification means said electrolyte film having ionic conductivity by
20 incorporating liquid electrolytes thereto. Although the solid electrolytes are not in a complete solid state since they contain liquid electrolytes, they are called "solid electrolytes" in order to be distinguished from the liquid electrolytes because the basic backbone of solid electrolytes starts from the electrolyte film at a solid state. In addition, the term
25 "absorbent" used in the specification means materials capable of absorbing liquid electrolytes or of increasing the ability of the solid electrolytes absorbing liquid electrolytes.

The process for assembling batteries refers to binding a cathode and an anode, which are separately prepared, with an interposed electrolyte film in the manner of lamination or pressing. When the electrolyte film is prepared by one of the said methods, liquid electrolytes are added after the assembly of battery, which can minimize the restriction on dehumidifying conditions in the process. Furthermore, according to the present method, the sites capable of absorbing liquid electrolytes are already formed in the course of manufacturing the electrolyte film and thus there is no need for the procedure of extracting a plasticizer. Therefore, the method has some advantages in that it simplifies the process, which not only reduces the production cost but also makes the automation process easy and improves the yield. In addition, when the electrolyte film is prepared by one of the said methods, the polymer matrix comes to have microporous structures, which facilitates the transfer of the liquid electrolyte, which in turn improves the lithium ionic conductivity of the solid electrolyte with the same amount of absorbent.

The solid electrolytes according to the present invention comprise an electrolyte film containing an inorganic absorbent and consisting of microporous structures, and an ion conductive liquid electrolyte.

Said electrolyte film can be preferably prepared by means of a phase inversion method. Examples of such method include wet process

and dry process. The wet process refers to a process for the preparation of an electrolyte film, which comprises the steps of:

dissolving a mixture of an absorbent and a polymer binder in a solvent for the polymer binder,

- 5 making the resulting solution to a film form,
 exchanging the solvent with a non-solvent for the polymer binder, and then
 drying the resulting material to form an electrolyte film.

- 10 On the contrary, the dry process refers to a process for the preparation of an electrolyte film, which comprises the steps of:

 mixing a mixture of an absorbent and a polymer binder with a solvent for dissolving the polymer binder, a non-solvent which does not dissolve the polymer binder, a pore former and a wetting agent,

- 15 making the resulting mixture into a film form, and
 drying the resulting film completely.

- Subsequently, an activation procedure of absorbing an ion
conductive liquid electrolyte into thus prepared porous electrolyte film
20 may lead to the formation of a solid electrolyte for rechargeable cells.

- Accordingly, the solid electrolyte of the present invention can be prepared by introducing an absorbent capable of absorbing the liquid electrolyte or increasing the absorption ability to the inside of the
25 electrolyte film to form a porous electrolyte film matrix and then injecting an liquid electrolyte thereto. Thus prepared solid electrolyte

has lithium ionic conductivity of approximately 1 to 3×10^{-3} S/cm at room temperature.

Examples of absorbents capable of absorbing liquid electrolytes
5 or increasing the absorption ability include organic materials such as porous polymers and inorganic materials such as mineral particles.

As porous polymer absorbents, polypropylene, polyethylene,
polystyrene and polyurethane to which porosity is introduced by means
10 of net type polymer wherein bulky functional groups are introduced to branched chains or by means of adjusting the parameters of the process according to the present invention can be used. Natural polymers such as wood powder, pulp, cellulose and cork may also be used.

15 As inorganic absorbents, it is possible to use one or two or more particles selected from the group consisting of mineral particles, synthetic oxide compounds particles and mesoporous molecular sieves. Examples of said mineral particles include mineral particles having phyllosilicate structures such as clay, paragonite, montmorillonite and
20 mica. Examples of said synthetic oxide compounds particles include zeolite, porous silica and porous alumina. Examples of mesoporous molecular sieves include mesoporous molecular sieves made of oxide compounds such as silica/polymer substance and having a pore diameter in 2 to 30 nm. Said mineral particles, synthetic oxide
25 compounds particles and mesoporous molecular sieves may be used in the form of a mixture wherein two or more absorbents selected from the above mentioned absorbents are combined.



Said inorganic absorbents have better mechanical, thermal and electrochemical stability as compared to organic absorbents such as porous polymers, and thus the performance properties of the rechargeable cells utilizing inorganic absorbents are better than those of the rechargeable cells utilizing organic absorbents.

Namely, it was found that when cells are fabricated by assembling an anode and a cathode by means of pressing method or lamination method, the organic absorbents differ from the electrolyte films or polymer binders of composite electrodes in their mechanical and thermal behaviors, and thus the rechargeable cells utilizing these organic absorbents show significant reduction in their discharge capacity during repeated charge and discharge as compared to the rechargeable cells utilizing inorganic absorbents. For example, absorbents consisting of organic materials such as polymers with low melting points or deteriorating mechanical strength may lose their absorption ability in the course of pressing or lamination procedures. In other words, the use of organic absorbents such as polymers may be beneficial to the performance of electrolyte films or solid electrolytes themselves, but it may be very difficult to maintain their original performance when cells are fabricated by means of the pressing or lamination method.

In addition, as explained above, since the transfer of polymer chains directly affects the ionic conductivity in general polymer electrolytes, the effect of temperature on ionic conductivity becomes

significant. Particularly, at low temperatures, the transfer of polymer chains is weakened, which significantly reduces the ionic conductivity, thereby resulting in severe deterioration in the performance of the cells. However, the use of absorbents as in the present invention increases the ionic conductivity. Moreover, if a large amount of inorganic absorbent, which is less affected by temperature, is used, the effect of temperature becomes less unlike the properties of general polymer electrolytes. As a large amount of inorganic absorbent is contained in electrolytes, the electrolytes have some merits in that the resistance against ignition or explosion is improved as compared to the electrolytes containing a large amount of organic material such as polymers.

Accordingly, it can be confirmed that it is preferable to use inorganic absorbents rather than use organic absorbents in the constitution of the electrolyte film of rechargeable cells.

The amount of absorbents added is 30 to 95 % by weight and preferably, 50 to 90 % by weight based on the weight of the dried state electrolyte film which does not contain liquid electrolyte. If the added amount exceeds 95 % by weight, the mechanical strength of the electrolyte film formed falls. If the amount is not more than 30 % by weight, the ability to absorb liquid electrolyte decreases.

The particle size of absorbents is preferably not more than 40 μm , more preferably, not more than 20 μm so as not to decrease the mechanical strength and the uniformity of the electrolyte film.

As polymer binders, it is possible to use most common polymers. Among them, it is preferred to use a mixture of one or two or more polymers selected from the group consisting of copolymers of polyvinylidene fluoride, vinylidene fluoride and hexafluoropropylene, copolymers of vinylidene fluoride and maleic anhydride, polyvinylchloride, polymethylmethacrylate, polymethacrylate, cellulose triacetate, polyurethane, polysulfone, polyether, polyolefine such as polyethylene or polypropylene, polyethylene oxide, polyisobutylene, polybutyldiene, polyvinylalcohol, polyacrylonitrile, polyimide, polyvinyl formal, acrylonitrilebutyldiene rubber, ethylene-propylene-diene-monomer, tetra(ethylene glycol)diacrylate, polydimethylsiloxane, polycarbonate and polysilicon, or copolymers thereof.

The present invention introduces porous structures to the electrolyte film used as a matrix for the solid electrolyte, which facilitates the transfer of liquid electrolyte, and thus improves the lithium ionic conductivity of the solid electrolyte with the use of same amount of absorbent. As methods for preparing said porous electrolyte film include the wet process and dry process, as explained above. The wet process is carried out by subjecting electrolyte film component to a casting and reacting the resulting film with a non-solvent to form microporous structures in the polymer matrix. The dry process is carried out by subjecting the electrolyte film components together with a non-solvent for introducing porosity and a pore former to molding to form a microporous electrolyte film.

As solvents for dissolving polymer binders, a mixture of one or two or more solvents selected from the group consisting of N-methylpyrrolidinone, dimethylformamide, dimethylacetamide, tetrahydrofuran, acetonitrile, cyclohexanone, chloroform, dichloromethane, hexamethylphosphoramide, dimethylsulfoxide, acetone and dioxane.

As non-solvents for the polymer binder, it is possible to use a mixture of one or two or more selected from the group consisting of water, ethanol, ethylene glycol, glycerol, acetone, dichloromethane, ethylacetate, butanol, pentanol, hexanol and ether.

As pore formers, it is preferred to use a mixture of one or two or more selected from the group consisting of 2-propanol, resorcinol, trifluoroethanol, cyclohexanol, hexafluoroisopropanol, methanol and hemiacetal obtained by the reaction of maleic acid with hexafluoroacetone.

As dipping agents, it is preferred to use nonionic surfactants, for example, Triton X-100 (manufactured by Aldrich Company), Igepal DM-710 (manufactured by GAF Company).

The liquid electrolytes, which contain absorbents and are to be absorbed in electrolyte film, can be prepared by dissolving lithium salt in an organic solvent. In the present invention, the absorption of the liquid electrolytes into electrolyte film is defined as "activation".

It is preferred that said organic solvents have high polarity and no reactivity to lithium metal so as to improve the degree of dissociation of ions by raising the polarity of electrolyte and to facilitate ion conduction by lowering local viscosity around ions.

5 Examples of such organic solvents include ethylene carbonate, propylene carbonate, dimethylcarbonate, diethylcarbonate, ethylmethylcarbonate, γ -butyrolactone, dimethylsulfoxide, 1,3-dioxane, tetrahydrofuran, 2-methyltetrahydrofuran, sulfolane, N,N-dimethylformamide, diglyme, triglyme and tetraglyme. In particular, it

10 is preferred that the organic solvent is used in the form of mixed solutions of two or more solvents consisting of high viscosity solvents and low viscosity solvents.

Said lithium salt is preferred to have low lattice energy and a

15 high degree of dissociation. Examples of such lithium salt include LiClO_4 , LiBF_4 , LiPF_6 , LiAsF_6 , LiSCN , LiCF_3SO_3 , $\text{LiN}(\text{CF}_3\text{SO}_2)_2$ and $\text{LiC}(\text{CF}_3\text{SO}_2)_3$. The selective mixtures thereof can also be used. The concentration of the lithium salt is preferably 0.5M to 2M.

20 The liquid electrolyte can be added in an amount of 30 to 90 % by weight, preferably 40 to 85 % by weight, based on the total amount of electrolytes including the liquid electrolyte.

The solid electrolyte according to the present invention is

25 characterized by the facts that it is easy to prepare when compared to prior polymer electrolytes; that it has higher ionic conductivity because the conduction of lithium ions proceeds via liquid phase; and that it is

not affected by moisture or temperature until it absorbs the liquid electrolyte or it is activated.

In the following, the process for the preparation of said solid electrolyte having porous structures is explained in greater detail.

Wet process

The solid electrolyte having porous structures according to the present invention can be prepared by five steps, i.e., mixing an absorbent with a polymer binder, dissolution of the resulting mixture, casting, making polymer matrix porous and drying/ activation.

First of all, an absorbent in powder form (particle size of not more than 40 μm) and a polymer binder are dry mixed in a closed container.

The resulting mixture of the absorbent and the polymer binder is dissolved in a solvent for the polymer binder. The solid content of said mixed solution is preferably 5 to 50 % by weight based on the total weight of the solution. If the content is not more than 5 % by weight, the mechanical strength of the electrolyte film decreases and if the content is more than 50 % by weight, the polymer binder cannot be dissolved sufficiently or the viscosity of the mixed solution becomes large, which is problematic.

In order to facilitate the dissolution of the polymer binder and to avoid the agglomeration between absorbent, a magnetic stirrer, a

mechanical stirrer, a planetary mixer or a high-speed disperser can be used to stir the mixed solution. While stirring, an ultrasonic stirrer may be adopted to prevent the absorbent from agglomerating or bubbling in the middle of mixing. In addition, if desired, the mixed solution may
5 be subjected to defoaming and filtration steps.

After the polymer binder is completely dissolved and uniformly mixed with the absorbent, the resulting mixture is made in the form of film with a regular thickness. For example, the mixed solution may be
10 poured on a flat glass plate or a Teflon plate and then be subjected to casting so that the resulting products have a regular thickness. Alternatively, the mixed solution may be extracted from a die with a regular space and then coated onto a substrate made of polymer film. Various other application methods can be selected. It is preferred that
15 the thickness of the film is controlled in the range of 10 to 200 μm . If the thickness of the film is not more than 10 μm , the mechanical strength decreases, and if the thickness of the film exceeds 200 μm , the ionic conductivity decreases, which is not preferable.

20 After casting in the form of film, in order to introduce porosity to the polymer matrix, the film was contacted with a non-solvent for the polymer binder to extract the solvent for the polymer binder. For example, it is possible to extract the solvent by soaking the film in a non-solvent pool containing a non-solvent. Accordingly, it is preferable
25 to combine a miscible solvent and a non-solvent. The time for soaking the film in a non-solvent pool varies from one minute to one hour depending on the kinds of the solvents and non-solvents. If the time is

shorter than the defined time, it is difficult to obtain sufficient porosity. On the contrary, if the time exceeds the defined time, the productivity becomes decreased, which is not preferable. The temperature in the pool is preferably from 10°C to 90°C, more preferably from 20°C to 80°C. If the temperature is lower than that, it is difficult to obtain sufficient porosity. If the temperature is excessively high, the mechanical strength of the electrolyte film decreases, which is not preferable. In general, it is preferable to introduce porosity corresponding to the amount of solvents in a mixed solution consisting of an absorbent, a polymer binder and a solvent. It is also preferable to control the composition, temperature and time of the mixed solution so that porosity can be introduced in accordance with the amount of solvents in a mixed solution.

After the extraction of the solvent and completely drying the resulting film, the liquid electrolyte is introduced thereto.

Dry process

The solid electrolyte having porous structures according to the present invention can be prepared by dry process consisting of four steps, i.e., mixing an absorbent with a polymer binder, adding additives (solvent, non-solvent, pore former, dipping agent), casting and drying/activation.

An absorbent in powder form (particle size of not more than 40 μm) and a polymer binder are dry mixed in a closed container. The

resulting mixture of absorbent and the polymer binder is dissolved in a solvent for the polymer binder.

In order to facilitate the dissolution of the polymer binder and to
5 avoid the agglomeration between absorbent, a magnetic stirrer, a mechanical stirrer, a planetary mixer or a high-speed disperser can be used to stir the mixed solution. While stirring, an ultrasonic stirrer may be used to prevent the absorbent from agglomerating or foaming in the middle of mixing. In addition, if desired, the mixed solution may be
10 subjected to defoaming and filtration steps.

After the polymer binder is completely dissolved and uniformly mixed with the absorbent, a solvent which does not dissolve the polymer binder, i.e., a non-solvent is added in an amount range of not
15 causing the precipitation of the polymer binder. In order to facilitate the formation of microporous structures, it is preferable to add pore formers or dipping agents. After said additives are uniformly mixed, the resulting mixture is molded in the form of film with a regular thickness. For example, the mixed solution may be poured on a flat
20 glass plate or a Teflon plate and then be subjected to casting so that the resulting products have a regular thickness. Alternatively, the mixed solution may be extracted from a die with a regular space and then coated onto a substrate made of polymer film. Besides, various other application methods can be selected. It is preferred that the thickness of
25 the film is controlled in the range of 10 to 200 μm . If the thickness of the film is not more than 10 μm , the mechanical strength decreases, and

if the thickness of the film exceeds 200 μm , the ionic conductivity decreases, which is not preferable.

After the completion of making in the form of film, the resulting
5 electrolyte film is completely dried at 20°C to 200°C and then the liquid electrolyte is introduced thereto.

When compared to the wet process, the dry process has a demerit in that a complete dispersing or mixing of the absorbents, polymer
10 binders and additives is comparatively difficult to accomplish. When a complete dispersion or mixing is not conducted, (i) it becomes difficult to accomplish an even dispersion of pores or absorbents, (ii) it is not easy to cast into the form of an electrolyte film and (iii) the mechanical strength and reproducibility become decreased. Namely, in the event
15 that the pores or absorbents are dispersed unevenly, it was confirmed that (i) the reaction in cells proceeds non-uniformly localized state when the electrolyte film is used as an electrolyte for electrochemical cells; (ii) the casting in the form of film becomes difficult; and (iii) the mechanical strength decreases, which limited the dry process severely.

20

In addition, the dry process necessitates the addition of non-solvents in order to form pores and in view of the principle of the dry process, the solvent should be evaporated (dried) prior to the non-solvents so that pores can be formed. If the non-solvents are evaporated
25 prior to the solvents, pores cannot be formed. In this regard, it is essential that the non-solvents should have non-volatile property or higher boiling points than solvents. For this reason, the dry process is



likely to have a problem of residual non-solvents. In other words, non-solvents, which have higher boiling point than solvents or are non-volatile, are difficult to remove completely from the electrolyte film during drying procedure. Therefore, a separate measure (for example, 5 extraction with alcohol or ether or increasing the drying temperature sufficiently) should be taken in order to remove completely the non-solvents. In addition, since said non-solvents are chemically and electrochemically unstable, if said non-solvents remain in the electrolyte film, they may cause side reactions or oxidation or reduction 10 with repeated charge and discharge of cells. As a result, the deterioration of cell performance such as capacity decrease of cells or gas evolution may happen. The same problems apply to the other additives besides non-solvents. It is considered that the process for the preparation of electrolyte film solely consisting of an absorbent and a 15 polymer binder by way of complete removal of additives or the like may be complicated, which render the reproducibility of this process difficult.

Accordingly, it is preferable to prepare the electrolyte films or 20 solid electrolytes by wet process rather than dry process.

The present invention is directed to rechargeable cells, particularly to rechargeable lithium cells wherein said porous solid electrolyte is used as an electrolyte.

25

The process for assembling batteries refers to binding a cathode and an anode, which are separately prepared, with an interposed

electrolyte film in the manner of lamination, pressing or winding. When the electrolyte film is prepared by one of the said methods, liquid electrolytes are added after the assembly of battery, which can minimize the restriction on dehumidifying atmosphere in the process.

5 Furthermore, according to the present method, the sites capable of absorbing liquid electrolytes are already formed in the course of manufacturing the electrolyte film and thus there is no need for the procedure of extracting a plasticizer. Therefore, the method has some advantages in that it simplifies the process, which not only reduces the

10 production cost but also makes the automation process easy and improves the yield. In addition, when an electrolyte film is prepared by the said method, the polymer matrix comes to have microporous structures, which facilitates the transfer of the liquid electrolyte and improves the lithium ionic conductivity of the solid electrolyte with the

15 same amount of absorbent.

In one embodiment of the method for the production of rechargeable cells by the use of the solid electrolyte according to the present invention, a cell can be constructed by bonding a cathode and

20 an anode, interposed with the porous electrolyte film prepared from the above-mentioned procedure. The porous electrolyte film contains absorbent powder therein and has porous structures, which make the electrolyte film maintain its condition facilitating the absorption of the liquid electrolyte. The cathode is electrically connected to a cathode

25 current collector; and the anode is electrically connected to an anode current collector. Thus the constructed assembly is activated to be able

to absorb the liquid electrolyte, thereby obtaining an electrochemical cell which is ready to operate.

Fig. 1 illustrates a cross sectional view of the rechargeable cell in which the solid electrolyte according to the present invention is used. The solid electrolyte (1) contains the absorbent powder (11) and the liquid electrolyte, which is absorbed during the activation step. The cathode (2) is electrically connected to a cathode current collector (22) and the anode (3) is electrically connected to an anode current collector (33), respectively.

The procedures for the preparation of the cathode or anode are as follows. The cathode or anode consists of a current collector and an active material layer. The active material layer comprises of active materials, conducting materials and binders, etc. Besides, various additives may be introduced in order to improve the performance of cells. The current collectors, conducting materials, binders and additives, which are contained in the cathode or anode, may be identical or different, depending on desired objectives.

20

The current collectors provide mobile pathways for electrons, which are generated in the oxidation/reduction reaction, taking place in the cathode or the anode. As current collectors, generally grids, foils, punching foils and etching foils, etc., may be used, depending on the performance or manufacturing processes of the cell. The use of grids can increase the filling rate of the active material, but it may complicate the manufacturing process. The use of foils can improve the

25

performance of the cell and simplify the manufacturing process, but it may deteriorate the compactness of the active materials. Copper, aluminum, nickel, titanium, stainless steel, carbon, etc., can be used as current collectors. Generally, aluminum is used for the cathode and
5 copper is used for the anode.

The active materials are the most crucial component of electrochemical cells since they determine the performance of cells in view of the fact that the charge and discharge reaction (or
10 oxidation/reduction reaction) of cells take place on these materials. Furthermore, the active materials possess the largest content in the active material layer. As cathode active materials, it is possible to use oxide compounds or sulfide compounds of transition metals, organic compounds, polymer compounds, etc. Preferably, it is possible to use
15 oxide compounds or polymer materials such as lithium cobalt oxide (Li_xCoO_2), lithium nickel oxide (Li_xNiO_2), lithium nickel cobalt oxide ($\text{Li}_x\text{Ni}_y\text{Co}_{1-y}\text{O}_2$), spinel type lithium manganese oxide ($\text{Li}_x\text{Mn}_2\text{O}_4$), manganese dioxide (MnO_2), etc. As anode active materials, alkali metals, alkali earth metals, carbon, oxide compounds or sulfide
20 compounds of transition metals, organic compounds and polymer compounds may be used, preferably carbon or polymer materials can be used. It is essential that the active materials should be chosen in accordance with the desired performance or use of cells.

25 The conducting materials refer to materials that are added to the cathode or anode in order to improve the electronic conductivity, and are generally carbon. Among them, conducting materials are preferably

graphite, cokes, activated carbon and carbon black, more preferably graphite and carbon black. One or two or more of conducting materials selected from the above group can be used and there is no difference whether they are synthetic or natural materials. The conducting materials are added in an amount of 3 to 15 % by weight based on the total weight of the electrode materials. If the amount of the conducting materials added is not more than 3 % by weight, the electrical conductivity falls, causing the problem of over voltage. If the amount exceeds 15% by weight, the energy density per unit volume decreases and the side reaction due to the conducting materials become severe.

The binders refer to components to be added to enhance the binding ability of the active materials and are generally polymer compounds. The polymer compounds that are used in the preparation of the solid electrolyte film may serve as binders. It is preferable to use binders, which are the same as polymers of the electrolyte film or have miscibility. The binders may be added in an amount of 15 % by weight or less based on the total weight of the electrode materials. If the amount of binders is less than required, the binding ability of the electrodes may decrease. If the amount of binders exceeds 15 % by weight, the processability and porosity of the electrodes decrease.

The additives refer to materials, which are added to improve the performance of cells or electrodes and can be chosen within a wide range in accordance with desired performances or use. The additives are added to improve the binding ability with composite electrodes inside or current collectors, to induce the porosity or non-crystallinity

of the composite electrodes, to improve the dispersibility of the composite electrode constituting materials or the efficiency of the process for the manufacturing of the electrodes, to prohibit the overcharge/overdischarge of the active materials, to recombine or
5 remove the side reaction products, or to improve the absorption ability of the liquid electrolytes. Generally, salts, organic/inorganic compounds, minerals and polymer compounds can be used as additives, and absorbents added to the electrolyte film can be chosen.

10 In the following, the rechargeable lithium cell according to the present invention will be explained in greater detail.

The porous electrolyte film in a dried solid condition obtained by the above-mentioned process without having the step introducing the
15 liquid electrolyte is assembled with a cathode and an anode prepared separately to form a cell, to which a liquid electrolyte is absorbed to obtain the rechargeable lithium cell. The solid electrolyte should be subjected to an activation step absorbing the liquid electrolyte in order to have a sufficient ionic conductivity for being used. By passing
20 through the activation step, the solid electrolyte comes to be workable as an electrochemical cell. In case that the solid electrolyte fails to pass through the activation step, the ionic conductivity at room temperature decreases drastically, which renders the solid electrolyte itself inappropriate as an electrolyte.

25

The process for the preparation of the cathode and/or anode to be assembled with said electrolyte film is as follows. Each mixture of the

cathode or anode materials is kneaded to give slurry. The resulting slurry is made to a thin film by means of casting, coating and screen printing and then the resulting thin film is combined with a current collector by means of pressing or lamination to form a cathode and/or an anode. Alternatively, the slurry may be directly coated on a current collector to form a cathode and/or an anode.

Onto the surface of the electrodes manufactured by the above mentioned methods a solid electrolyte slurry consisting of an absorbent, a polymer binder and a solvent may be directly applied to form a cell in which an electrolyte film is formed on the electrodes. Alternatively, one may constitute a cell by lamination or pressing the separately manufactured electrodes and electrolyte film. When a cell is constructed by the former method, the binding ability between the electrodes and the electrolyte film may increase. However, it will be hard to adopt the former method when the electrodes and the electrolyte film do not correspond with each other, or when the electrodes or the electrolyte film are easy to pollute or lose their performance in the course of manufacturing process. Moreover, in case that the electrolyte film is prepared by the dry process, electrodes may be contaminated by the non-solvents or pore formers which are used to introduce porous structures, which is problematic. Particularly, when water is used as a non-solvent or a pore former, the cell performance may be deteriorated if water is not completely removed by sufficient drying step. In addition, there is a problem in that it is very hard to approach the complete drying condition. In the latter method, although there is a demerit in that the binding ability between the electrodes and

the electrolyte film is weak, there are much better merits in that it simplifies the quality control, process design and equipment used. Therefore, the latter method is preferred to the former one.

5 The electrolyte film prepared by the present invention contains an absorbent and thus has advantages in that it has higher mechanical strength as compared to pure electrolyte films or other electrolyte films containing gel type polymer electrolytes or plasticizers. Accordingly, because the electrolyte film of the present invention shows little change
10 in its shape during the pressing or lamination procedure and has high reproducibility, it has merits in that it can be produced with a low failure rate and on a large scale. Namely, it can be stated that the electrolyte film prepared by the present invention has properties suitable for pressing or lamination methods, which are more
15 advantageous in terms of quality control, process design and equipment used.

Brief Description of Drawings

20 Figure 1 is a cross sectional view of the cell wherein the solid electrolyte according to the present invention is used.

Figure 2 shows graphs demonstrating the experimental results of linear sweep voltammetry to determine the electrochemical stability of
25 the solid electrolyte according to the present invention.

Figure 3 shows a variation of discharge capacity of the cell in which the solid electrolyte containing an inorganic absorbent is used as compared to the cell in which polymer absorbent is used with repeated charge and discharge.

5

Drawing Reference Numerals:

- | | |
|----------------------|-------------------------------|
| 1: solid electrolyte | 11: absorbent powder |
| 2: cathode | 22: cathode current collector |
| 3: anode | 33: anode current collector |

10

Best Mode for Carrying out the Invention

In the present invention, the solid electrolyte according to the present invention and the process for the preparation of cells by using said solid electrolyte are explained in detail. Firstly, the production of the solid electrolyte and the examination of performances were carried out. In addition, the solid electrolyte is assembled together with the anode and cathode to form a cell and then the procedure to examine the performance of the cell is described. However, the present invention is not restricted to those examples and various modifications are possible within the scope of the invention.

20

Example 1 (wet process)

An absorbent and PVdF powder were introduced to a 20 ml vial and then dry mixed for approximately 5 minutes with a magnetic stirrer. To the resulting mixture 4 ml of N-methyl pyrrolidinone was added and then continuously stirred until the binder was completely

25

dissolved. In order to prohibit the absorbent particles from agglomerating with each other, the resulting solution was further subjected to ultrasonic stirring for 30 minutes while stirring. The mixed solution thus prepared was coated onto a glass plate in thickness of 100 μm . The coated film was soaked in a non-solvent bath for approximately 10 minutes, which was removed from the bath and then dried at 40°C for 1 hour. The porous electrolyte film thus prepared was soaked in a liquid electrolyte solution for approximately 10 minutes. After the liquid electrolyte was completely absorbed, the weight change was determined. The ionic conductivity was also determined by the use of an alternate current impedance method.

Table 1 summarizes the kinds of absorbents and binders, the properties of the porous solid electrolyte in accordance with its content and conductivity. In order to compare the ability of the porous electrolyte film absorbing the liquid electrolyte, sorption capacity (Δ_{ab}) was defined as follows:

$$\Delta_{ab} = [\text{amount of the liquid electrolyte absorbed (mg)}] / [\text{weight of the electrolyte film (mg)}]$$

Table 1

Ex.	Absorbents		PV dF	non- solvent	Liquid Electrolyte	Δ_{ab}	Ionic Conducti vity mS/cm	Mechani cal strength
	Kind	g						
a	Paragonite	0.13	0.28	H ₂ O	EC/DMC 1M LiPF ₆	7.0	2.1	Good
b	Paragonite	0.17	0.26	H ₂ O	EC/DMC 1M LiPF ₆	6.8	2.2	Good
c	Paragonite	0.72	0.24	H ₂ O	EC/PC 1M LiPF ₆	6.9	1.9	Good
d	Paragonite	1.06	0.26	H ₂ O	EC/PC 1M LiPF ₆	7.5	1.8	Good
e	Paragonite	1.51	0.26	H ₂ O	EC/DMC 1M LiPF ₆	8.0	2.4	Good
f	Paragonite	2.00	0.26	H ₂ O	EC/DMC 1M LiPF ₆	8.5	2.5	Good
g	Paragonite	1.98	0.25	Ethanol	EC/DMC 1M LiPF ₆	5.1	1.0	Good
h	Zeolite	1.37	0.60	H ₂ O	EC/DMC 1M LiPF ₆	7.2	1.9	Good
i	Zeolite	1.50	0.38	H ₂ O	EC/DMC 1M LiPF ₆	8.2	2.0	Good
j	Zeolite	1.65	0.29	H ₂ O	EC/DMC 1M LiPF ₆	8.0	2.4	Good
k	Montmoril lonite	1.34	0.58	H ₂ O	EC/DMC 1M LiPF ₆	8.0	2.8	Good
l	Montmoril lonite	1.50	0.38	H ₂ O	EC/DMC 1M LiPF ₆	8.2	2.9	Good
m	Porous Silica	1.35	0.59	H ₂ O	EC/DMC 1M LiPF ₆	8.5	2.4	Good
n	Polypropyl ene	1.35	0.60	H ₂ O	EC/DMC 1M LiPF ₆	7.0	1.9	Good
o	Wood powder	1.35	0.60	H ₂ O	EC/DMC 1M LiPF ₆	7.4	2.0	Good

5 Example 2 (wet process)

Paragonite powder and a binder powder were introduced to a 20 *ml* vial and then dry mixed for approximately 5 minutes with a magnetic stirrer. To the resulting mixture 4 *ml* of N-methyl pyrrolidinone was added and then continuously stirred until the binder was completely dissolved. In order to prohibit the absorbent particles from agglomerating with each other, the resulting solution was further

subjected to ultrasonic stirring for 30 minutes while stirring. The mixed solution thus prepared was coated onto a glass plate in thickness of 100 μm . The coated film was soaked in a water bath for 10 minutes, which was removed from the bath and then dried at 40°C for approximately one hour. The porous electrolyte film thus prepared was soaked in a liquid electrolyte solution for approximately 10 minutes. After the liquid electrolyte was completely absorbed, the weight change was determined. The ionic conductivity was also determined by the use of an alternate current impedance method. The results are summarized in Table 2.

Table 2

E x.	Paragonite	Binder		Liquid Electrolyte	Δ_{ab}	Ionic Conducti vity mS/cm	Mechani- cal strength
	G	Kind	g				
a	1.98	PVdF	0.24	EC/DMC 1M LiPF ₆	8.1	2.4	Good
b	2.00	P(VdF-HFP)	0.26	EC/DMC 1M LiPF ₆	8.0	2.6	Good
c	1.95	PAN	0.25	EC/DMC 1M LiPF ₆	7.8	2.2	Good
d	2.00	PU	0.26	EC/DMC 1M LiPF ₆	8.9	2.9	Good
e	1.98	PVC	0.25	EC/DMC 1M LiPF ₆	7.4	2.0	Good
f	2.00	P(VdF-HFP)	0.26	EC/DMC 1M LiPF ₆	8.5	2.5	Good

15 Example 3 (dry process)

1.17 g of paragonite and 0.5 g of P(VdF-HFP) were introduced to a 20 ml vial and then dry mixed for approximately 5 minutes with a magnetic stirrer. To the resulting mixture 8 g of acetone was added and

then continuously stirred until the binder was completely dissolved. In order to prohibit the absorbent particles from agglomerating with each other, the resulting solution was further subjected to ultrasonic stirring for 30 minutes while stirring. To the resulting mixed solution 0.9 g of ethylene glycol, 0.1 g of Triton X-100 and 1.8 g of isopropanol were added and then the resulting mixture was subjected to ultrasonic stirring for approximately 10 minutes until the added mixture was uniformly mixed. The mixed solution thus prepared was coated onto a glass plate in thickness of 100 μm . The coated film was dried at 40°C for approximately 2 hours, which was further dried for approximately 6 hours in a vacuum drier set to 50°C. The electrolyte film thus prepared was soaked in an EC/DEC 1M LiPF_6 solution for approximately 10 minutes. After the liquid electrolyte was completely absorbed, the weight change was determined. Δ_{ab} value measured by the use of the weight change was 7.5. The conductivity determined at room temperature by an alternate current impedance method was 2.0×10^{-3} S/cm.

Example 4 (Comparative Example)

20

2 g of paragonite and 0.26 g of PVdF were introduced to a 20 ml vial and then dry mixed for approximately 5 minutes with a magnetic stirrer. To the resulting mixture 4 ml of N-methyl pyrrolidinone was added and then continuously stirred until the binder was completely dissolved. In order to prohibit the absorbent particles from agglomerating with each other, the resulting solution was further subjected to ultrasonic stirring for 30 minutes while stirring. The

mixed solution thus prepared was coated onto a glass plate in thickness of 100 μm . The coated film was dried at room temperature for approximately 2 hours and then was further dried for 6 hours in a vacuum drier. The temperature of the vacuum drier was controlled to approximately 50°C. The present example differs from Examples 1 to 3 in the fact that a process for forming porous structures was not conducted. The electrolyte film thus prepared was soaked in a liquid electrolyte solution for approximately 10 minutes. After the liquid electrolyte was completely absorbed, the weight change was determined. The conductivity was determined by the use of an alternate current impedance method. Lithium ionic conductivity measured at room temperature was $7.0 \times 10^{-4} \text{ S/cm}$.

Example 5

15

In order to determine the electrochemical stability of the porous solid electrolyte, the linear sweep voltammetry method was carried out by the use of a stainless steel (#304) as an operating electrode and lithium metal as an opposite electrode and a standard electrode. The electrochemical voltage applied in the linear sweep voltammetry was from an open circuit voltage to 5.5V. The scan rate of the linear sweep voltammetry was 10mV/sec. The results of the linear sweep voltammetry measured on the porous solid electrolyte prepared by the methods of Example 1-(f), 1-(j), 1-(l) and 2-(s) are shown as A, B, C and D, respectively, in Fig. 2.

25

Example 6

In order to determine the performances of the cell using the solid electrolyte, an oxide compound cathode, a carbon anode and a solid electrolyte according to the present invention were assembled to fabricate cells, and then the charge and discharge test on thus fabricated cells was carried out. The fabricated cells were in a laminated form and were prepared by lamination of the cathode, anode and electrolyte film to form an assembly, to which a liquid electrolyte was absorbed. The constant current was applied with a rate charging the reversible capacity within 2 hours (C/2 rate) until the cell voltage became 4.2 V, and then the constant voltage of 4.2 V was applied again until the current decreased down to C/10 mA. Subsequently, the discharging current was applied with a rate discharging the voltage down to 2.5 V or 2.75 V within 2 hours (C/2 rate). The charge and discharge experiment was repeated and the change of discharge capacity with the charge and discharge was measured. The cell constitution and the test results are summarized in the following Table 3 and shown in Fig. 3. As listed in Table 3, the solid electrolyte refers to the conditions where a liquid electrolyte is absorbed into an electrolyte film. In addition, the solid electrolyte obtained in Example 4 was not applied for cell tests.

Table 3

Ex.	Cathode				Anode				Solid Electrolyte	Fig.
	Active material	Conducting material	Binder	Additive	Active material	Conducting material	Binder	additive		
v	LiCoO ₂	Carbon black	PVdF	Paragonite	Graphite	Carbon black	PVdF	Paragonite	Ex. 1-(c)	Fig. 3-E
w	LiCoO ₂	Carbon black	PVdF	Zeolite	Graphite	Carbon black	PVdF	Zeolite	Ex. 1-(j)	Fig. 3-F
x	LiCoO ₂	Carbon black	PVdF	Zeolite	Graphite	Carbon black	PVdF	Zeolite	Ex. 1-(n)	Fig. 3-G
y	LiCoO ₂	Carbon black	P(VdF-HFP)	Zeolite	Graphite	Carbon black	P(VdF-HFP)	Zeolite	Ex. 3	Fig. 3-H
z	LiMn ₂ O ₄	Carbon black	P(VdF-HFP)	Paragonite	Graphite	Carbon black	P(VdF-HFP)	Paragonite	Ex. 2-(q)	Fig. 3-I

Fig.3 illustrates the discharge capacity with repeated charge and discharge of the cell obtained by the respective examples in comparison with the first discharge capacity. From the test results, it was confirmed that the use of the solid electrolytes containing inorganic absorbents (Examples 6-v, w, z) shows much better cell performances than that of the solid electrolyte containing organic absorbents such as polymers (Example 6-x). Furthermore, it was also confirmed that the use of solid electrolytes obtained by the wet process according to the present invention (Examples 1 and 2) shows much better cell performances than that of the solid electrolyte obtained by the dry process (Example 6-y). Namely, the solid electrolyte containing inorganic absorbent and prepared by the wet process has a much better effect on the total cell performances (charge and discharge performance, etc.), although the electrolyte film or solid electrolyte itself does not show any significant differences in properties (ionic conductivity, mechanical strength, etc.).

Industrial Applicability

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The microporous solid electrolytes according to the present invention are characterized by the following facts:

they have high mechanical strength, which makes them suitable to be made into thin films;

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they have high ionic conductivity corresponding to that of the liquid electrolytes since the microporous structures and absorbents

introduced to the polymer matrix facilitate the absorption of the liquid electrolyte and there is no restriction on the transfer of lithium ions;

unlike general polymer electrolytes in gel type, they do not require any particular dehumidifying atmosphere since lithium salt, which is easily decomposed by a trace amount of moisture, is not introduced during the manufacturing of the electrolyte films;

they have a broad electrochemical potential window since the absorbent therein is electrochemically stable; and

they are of ease in automation for mass production due to the simple process for the production of the electrolyte.

In addition, it is possible for the microporous solid electrolyte according to the present invention to minimize the surface resistance between the electrolyte and electrodes since the binding ability with the cathode and anode is excellent and the volume change due to the introduction of the liquid electrolyte is little. Therefore, the microporous solid electrolyte according to the present invention is suitable for being used as an electrolyte for rechargeable lithium cells. The solid electrolytes containing inorganic absorbents also show superior mechanical, thermal and electrochemical stability to those of the solid electrolytes containing organic absorbents, thereby showing less decrease in their discharge capacity during the repeated charge and discharge. When introducing porous structures to the electrolyte, the wet process is more efficient and stable than the dry process. The microporous solid electrolyte shows superior performances such as less decrease in their discharge capacity as mentioned above when they are used to form electrochemical cells.

WHAT IS CLAIMED IS:

1. A solid electrolyte for rechargeable cells, comprising:
 - 5 an electrolyte film having a thickness of 10 to 200 μm and microporous structures; and
 - an ion conductive liquid electrolyte in an amount of 30 to 90 % by weight based on the total weight of the electrolyte including liquid electrolyte,
 - 10 wherein said electrolyte film contains an absorbent having a particle size not more than 40 μm in an amount of 30 to 95 % by weight based on the total weight of the electrolyte film under the dried condition that no liquid electrolyte is contained therein.
- 15 2. A solid electrolyte for rechargeable cells according to Claim 1, in which said electrolyte film is prepared by the wet process comprising the steps of:
 - dissolving a mixture of an absorbent and a polymer binder in a solvent for the polymer binder,
 - 20 making the resulting solution into a film,
 - exchanging the solvent with a non-solvent for the polymer binder, and then drying the resulting material.
- 25 3. A solid electrolyte for rechargeable cells according to Claim 1, in which said electrolyte film is prepared by the dry process comprising the steps of:

dissolving a mixture of an absorbent and a polymer binder in a solvent for the polymer binder,

adding a non-solvent for the polymer binder, a pore former and a dipping agent to the resulting solution, and

5 making the resulting solution into a film and then drying the resulting film.

4. A solid electrolyte for rechargeable cells according to Claim 2 or Claim 3, in which

10 said solid electrolyte is prepared by an activation procedure in which an ion conductive liquid electrolyte is absorbed into said electrolyte film, and

said ion conductive liquid electrolyte is obtained by dissolving one or two or more lithium salts selected from the group consisting of
15 LiClO_4 , LiBF_4 , LiPF_6 , LiAsF_6 , LiSCN , LiCF_3SO_3 , $\text{LiN}(\text{CF}_3\text{SO}_2)_2$ and $\text{LiC}(\text{CF}_3\text{SO}_2)_3$ in a mixture of one or two or more organic solvents selected from the group consisting of ethylene carbonate, propylene carbonate, dimethylcarbonate, diethylcarbonate, ethylmethylcarbonate, γ -butyrolactone, 1,3-dioxane, tetrahydrofuran, 2-
20 methyltetrahydrofuran, dimethylsulfoxide, sulfolane, N,N-dimethylformamide, diglyme, triglyme and tetraglyme in a concentration of 0.5M to 2M.

5. A solid electrolyte for rechargeable cells according to Claim 2 or
25 Claim 3, in which

said absorbent is a mixture of one or two or more selected from the group consisting of porous polymer particles such as polyethylene,

polypropylene, polystyrene, polyurethane, pulp, cellulose, cork and wood powder; mineral particles such as clay, paragonite, montmorillonite and mica; synthetic oxide compounds particles such as zeolite, porous silica and porous alumina; mesoporous molecular sieves
5 having 2 to 30 nm of pore diameter made of oxide compounds or polymers; and other commercially available absorbents;

said polymer binder is a mixture of one or two or more selected from the group consisting of copolymers of polyvinylidene fluoride, vinylidene fluoride and hexafluoropropylene, copolymers of vinylidene
10 fluoride and maleic anhydride, polyvinylchloride, polymethylmethacrylate, polymethacrylate, cellulose triacetate, polyurethane, polysulfone, polyether, polyethylene, polypropylene, polyethylene oxide, polyisobutylene, polybutylidene, polyvinylalcohol, polyacrylonitrile, polyimide, polyvinyl formal, acrylonitrilebutyldiene
15 rubber, ethylene-propylene-diene-monomer, tetraethyleneglycol diacrylate, polydimethylsiloxane, polycarbonate and silicon polymer, or their copolymer;

said solvent for dissolving polymer binders is a mixture of one or two or more solvents selected from the group consisting of N-
20 methylpyrrolidinone, dimethylformamide, dimethylacetamide, tetrahydrofuran, acetonitrile, cyclohexanone, chloroform, dichloromethane, hexamethylphosphoramide, dimethylsulfoxide, acetone and dioxane; and

said non-solvent for the polymer binders is a mixture of one or
25 two or more selected from the group consisting of water, ethanol, ethylene glycol, glycerol, acetone, dichloromethane, ethylacetate, butanol, pentanol, hexanol and ether.

6. A solid electrolyte for rechargeable cells according to Claim 5, in which said absorbent is a mixture of one or two or more selected from the group consisting of mineral particles, synthetic oxide compounds
5 particles and mesoporous molecular sieves.

7. A lithium rechargeable cell, which is obtained by the following steps of:

dissolving a mixture of an absorbent and a polymer binder in a
10 solvent for the polymer binder,

making the resulting solution into a film,

exchanging said solvent with a non-solvent for the polymer binder and drying it to form a microporous electrolyte film containing the absorbent,

15 assembling the resulting electrolyte film together with a cathode and an anode separately prepared to form a cell, and then

subjecting the resulting cell to absorb an ion conductive liquid electrolyte.

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DRAWINGS

Fig. 1

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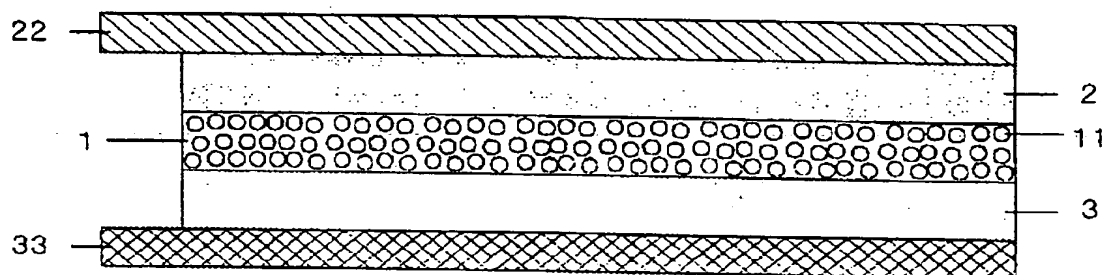
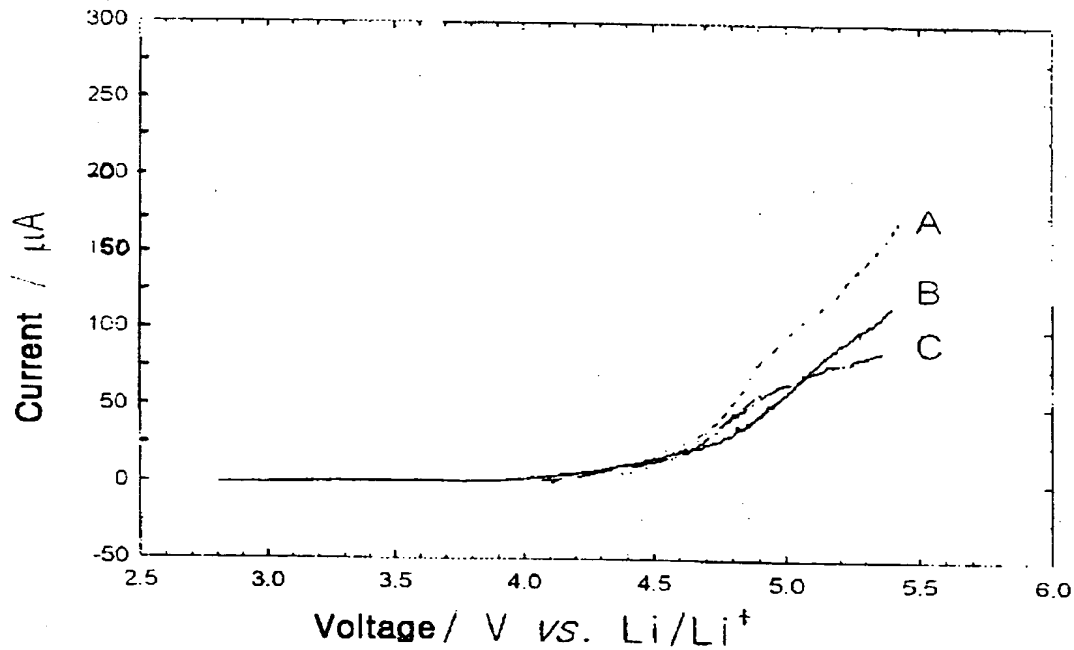


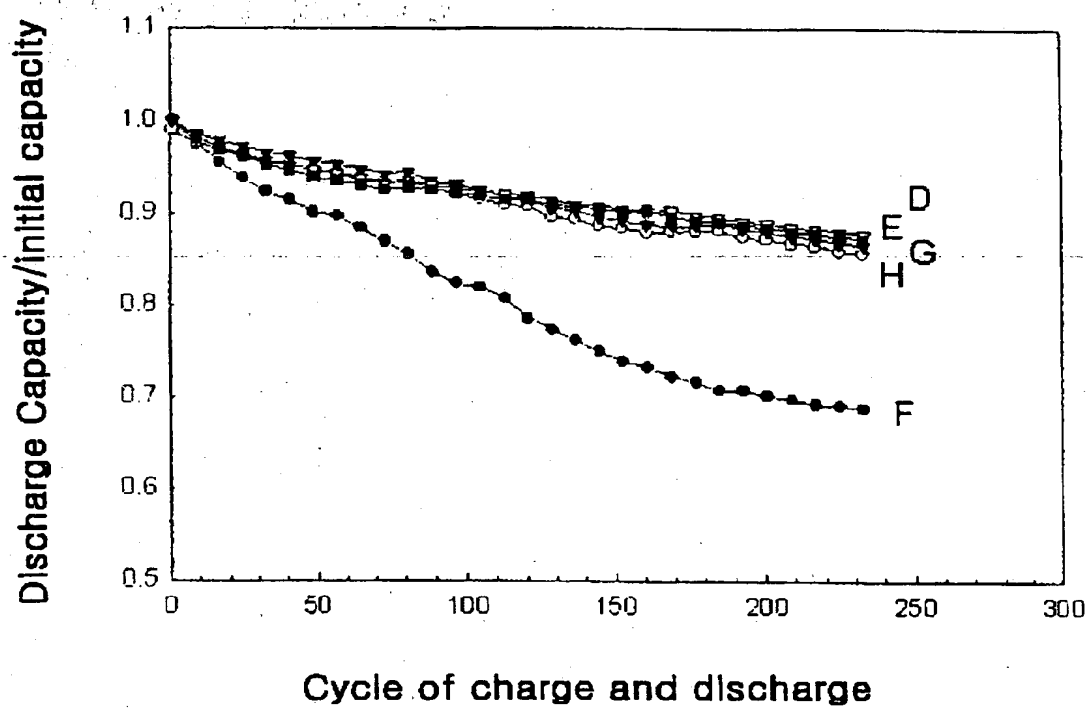
Fig. 2



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Fig. 3



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR99/00798

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H01M 10/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patents and applications for inventions since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

IEL(IEEE/IEE Electronic Library), Since 1988, solid <and> electrolyte <and> lithium

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,079,109 A (TOSHIBA BATTERY CO), 7 January 1992, See abstract	4
A	YASUMASA NAKAJIMA, YUICHI AIHARA, SIRO KATO and KAZUO MURATA 'Development of Film-like Lithium Battery Using Solid Polymer Electrolyte' In: Telecommunications Energy Conference, 1995. INTELEC '95., 17th International Published: 1995, Page(s): 704 - 709 See Fig. 4	1-7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

30 MARCH 2000 (30.03.2000)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

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KWON, Oh Bok

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PCT INTERNATIONAL COOPERATION TREATY

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NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

SOHN, Chang, Kyu
401, In-bong Building
640-21, Yoksam-dong
Kangnam-gu
Seoul 135-090
RÉPUBLIQUE DE CORÉE

Date of mailing (day/month/year) 04 August 2000 (04.08.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference FINE26(P)	
International application No. PCT/KR99/00798	International filing date (day/month/year) 21 December 1999 (21.12.99)

1. The following indications appeared on record concerning:

☐ the applicant ☐ the inventor ☒ the agent ☐ the common representative

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	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address SOHN, Chang, Kyu 401, In-bong Building 640-21, Yoksam-dong Kangnam-gu Seoul 135-090 Republic of Korea	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Simin Baharlou
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

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PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents
United States Patent and Trademark
Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing:

29 June 2000 (29.06.00)

International application No.:

PCT/KR99/00798

Applicant's or agent's file reference:

FINE26(P)

International filing date:

21 December 1999 (21.12.99)

Priority date:

22 December 1998 (22.12.98)

Applicant:

JANG, Dong, Hun et al

1. The designated Office is hereby notified of its election made:



in the demand filed with the International preliminary Examining Authority on:

03 April 2000 (03.04.00)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was



was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

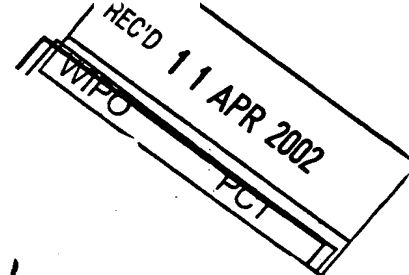
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09/868,227

COPY FOR IB

PATENT COOPERATION TREATY

PCT



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

4

Applicant's or agent's file reference FINE26(P)	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/KR99/00798	International filing date (day/month/year) 21 DECEMBER 1999 (21.12.1999)	Priority date (day/month/year) 22 DECEMBER 1998 (22.12.1998)
International Patent Classification (IPC) or national classification and IPC IPC7 H01M 10/36		
Applicant FINECELL Co., Ltd. et al		

CORRECTED VERSION

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 03 APRIL 2000 (03.04.2000)	Date of completion of this report 13 APRIL 2001 (13.04.2001)
Name and mailing address of the IPEA/KR Korean Intellectual Property Office Government Complex-Taejon, Dunsan-dong, So-ku, Taejon Metropolitan City 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer KWON, Oh Bok Telephone No. 82-42-481-5994



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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/KR99/00798

I. Basis of the report

1. With regard to the elements of the international application:*

- ☐ the international application as originally filed
- ☒ the description:
pages 1 - 37, as originally filed
pages, filed with the demand
pages, filed with the letter of
- ☒ the claims:
pages 38 - 41, as originally filed
pages, as amended (together with any statement) under Article 19
pages, filed with the demand
pages, filed with the letter of
- ☒ the drawings:
pages, as originally filed
pages 1/2 - 2/2, filed with the demand
pages, filed with the letter of
- ☒ the sequence listing part of the description:
pages None, as originally filed
pages None, filed with the demand
pages None, filed with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language English which is

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheet

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/KR99/00798

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-7	YES
	Claims		NO
Inventive step (IS)	Claims	1-7	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-7	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Reference is made to the following documents :

D1 : US-A-5079109

D2 : 'Development of Film-Like Lithium Battery Using Solid Polymer Electrolyte' In : Telecommunications Energy Conference, 1995

1. D1 discloses a nonaqueous electrolyte prepared by dissolving an electrolyte salt in a solvent mixture consisting of ethylene carbonate, 2-methylhydrofuran, and subjected to a treatment of bringing said composition in contact with an insoluble absorbent, but does not disclose an electrolyte film having a thickness of 10 to 0.2 mm and microporous structures.

D2 discloses electrolyte film but does not disclose an ion conductive liquid electrolyte and an absorbent contained in electrolyte film.

Accordingly the subject-matter of claims 1 and 7 seems to be novel(Article 3(2) PCT).

2. Neither D1 nor D2 suggests an electrolyte film having a microporous structures.

Thus claims 1 and 7 also involve an inventive step and meet the requirement of Article 33(3) PCT.

3. Claims 2-6 also comply with Article 33(2) and (3) PCT as they are dependent claims.

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/KR99/00798

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

<u>Application No. Patent No.</u>	<u>Publication date (day/month/year)</u>	<u>Filing date (day/month/year)</u>	<u>Priority date (valid claim) (day/month/year)</u>
US-A-5079109	07/01/92	15/05/90	16/05/89

2. Non-written disclosures (Rule 70.9)

<u>Kind of non-written disclosure</u>	<u>Date of non-written disclosure (day/month/year)</u>	<u>Date of written disclosure referring to non-written disclosure (day/month/year)</u>

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DRAWINGS

Fig. 1

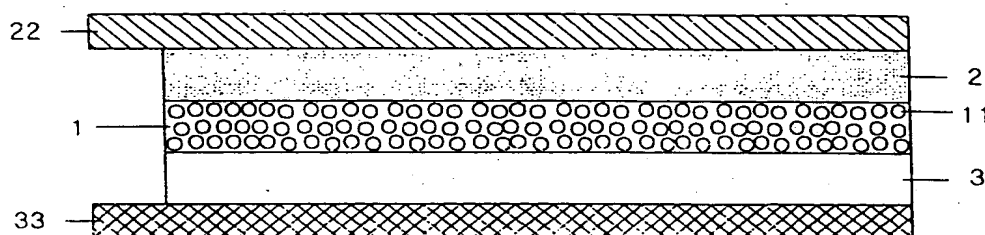
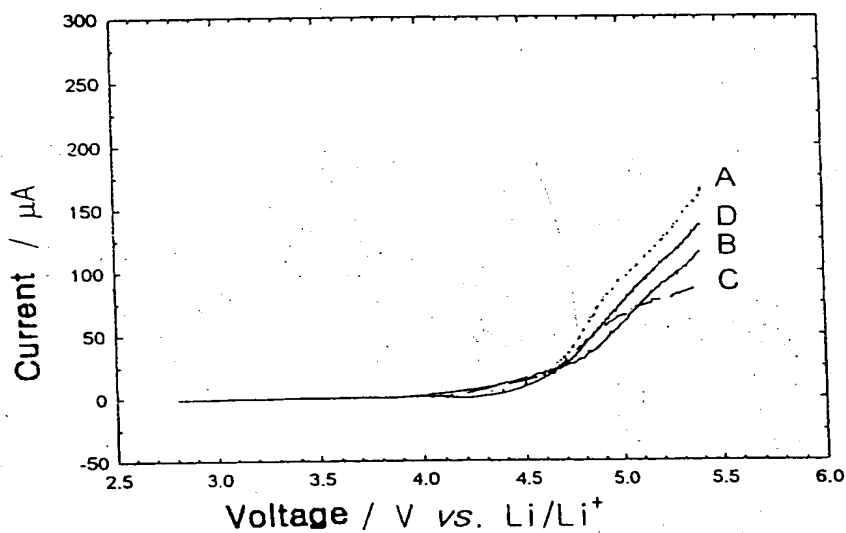


Fig. 2

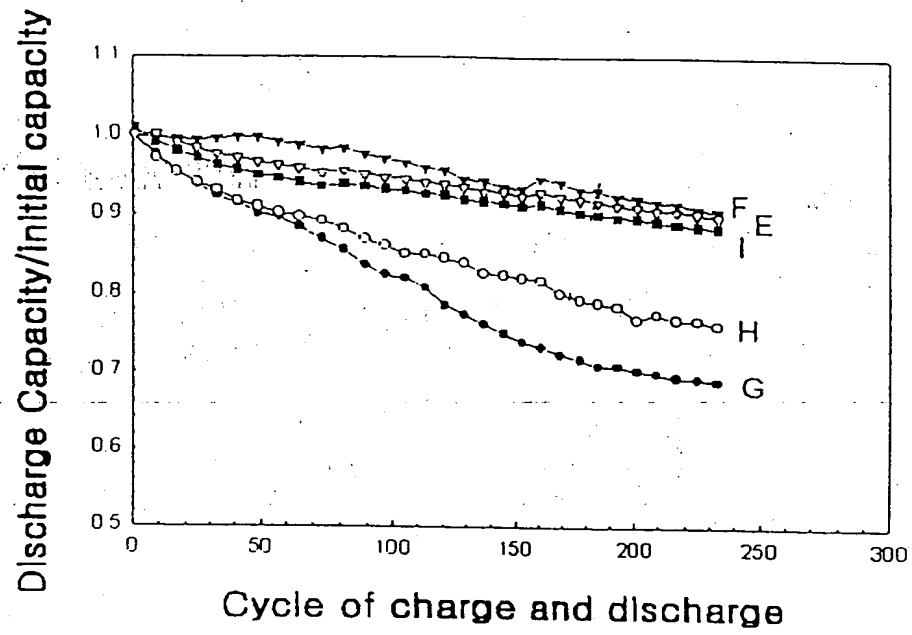


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Fig. 3



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PATENT COOPERATION TREATY

PCT

INFORMATION CONCERNING ELECTED
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

From the INTERNATIONAL BUREAU

To:

SOHN, Chang, Kyu
17th floor
Marine Center Main Building
118 Namdaemun-ro 2-ka
Chung-ku
Seoul 100-770
RÉPUBLIQUE DE CORÉE

Date of mailing (day/month/year) 29 June 2000 (29.06.00)		IMPORTANT INFORMATION	
Applicant's or agent's file reference FINE26(P)			
International application No. PCT/KR99/00798	International filing date (day/month/year) 21 December 1999 (21.12.99)	Priority date (day/month/year) 22 December 1998 (22.12.98)	
Applicant FINECELL CO., LTD. et al			

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE
National : CN, JP, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

None

3. The applicant is reminded that he must enter the "national phase" **before the expiration of 30 months from the priority date** before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed **until 31 months from the priority date** for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35	Authorized officer: J. Zahra Telephone No. (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:

SOHN, Chang, Kyu
17th floor
Marine Center Main Building
118 Namdaemun-ro 2-ka
Chung-ku
Seoul 100-770
RÉPUBLIQUE DE CORÉE

Date of mailing (day/month/year) 29 June 2000 (29.06.00)		
Applicant's or agent's file reference FINE26(P)		IMPORTANT NOTICE
International application No. PCT/KR99/00798	International filing date (day/month/year) 21 December 1999 (21.12.99)	
		Priority date (day/month/year) 22 December 1998 (22.12.98)
Applicant FINECELL CO., LTD. et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
CN,JP,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
EP

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
29 June 2000 (29.06.00) under No. WO 00/38263

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

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PARENT COOPERATION TREATY

PCT

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

From the INTERNATIONAL BUREAU

To:

SOHN, Chang, Kyu
17th floor
Marine Center Main Building
118 Namdaemun-ro 2-ka
Chung-ku
Seoul 100-770
RÉPUBLIQUE DE CORÉE

Date of mailing (day/month/year) 18 January 2000 (18.01.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference FINE26(P)	International application No. PCT/KR99/00798

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

FINECELL CO., LTD. (for all designated States except US)
JANG, Dong, Hun et al (all designated States)
HONG, Sung, Min (for US)

International filing date : 21 December 1999 (21.12.99)
Priority date(s) claimed : 22 December 1998 (22.12.98)
Date of receipt of the record copy
by the International Bureau : 04 January 2000 (04.01.00)
List of designated Offices :

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE
National : CN, JP, US

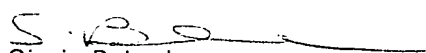
ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- ☒ time limits for entry into the national phase
☒ confirmation of precautionary designations
☒ requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer:  Simin Baharlou
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

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INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB/301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is 20 MONTHS from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, 30 MONTHS from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. **It is the applicant's responsibility** to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.

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PATENT COOPERATION TREATY

PCT

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

From the INTERNATIONAL BUREAU

To:

SOHN, Chang, Kyu
17th floor
Marine Center Main Building
118 Namdaemun-ro 2-ka
Chung-ku
Seoul 100-770
RÉPUBLIQUE DE CORÉE

Date of mailing (day/month/year) 20 February 2000 (20.02.00)	
Applicant's or agent's file reference FINE26(P)	IMPORTANT NOTIFICATION
International application No. PCT/KR99/00798	International filing date (day/month/year) 21 December 1999 (21.12.99)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 22 December 1998 (22.12.98)
Applicant FINECELL CO., LTD. et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
22 Dec 1998 (22.12.98)	1998/57031	KR	14 Febr 2000 (14.02.00)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Marc Salzman

Telephone No. (41-22) 338.83.38



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The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below.

IPEA/ KR

대표자	과장	차장	부장	사무장	변리사	인정사

PCT

DEMAND

CHAPTER II

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA		Date of receipt of DEMAND	
Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION		Applicant's or agent's file reference FINE26(P)	
International application No. PCT/KR99/00798 ✓	International filing date (day/month/year) 21 December 1999 (21. 12. 99) ✓	(Earliest) Priority date (day/month/year) 22 December 1998 (22. 12. 98) ✓	
Title of invention Microporous Solid Electrolytes And Methods For Preparing Them			
Box No. II APPLICANT(S)			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) FINECELL Co., Ltd. ✓ Room No. Ka-Dong 407, Factory Apartment 150 Yatap-Dong, Pundang-Gu, Sungnam-City Kyungki-Do 463-070, Republic of Korea		Telephone No.: 82-342-704-4546	
		Facsimile No.: 82-342-781-4540	
		Teleprinter No.:	
State (that is, country) of nationality: KR		State (that is, country) of residence: KR	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) JANG, Dong Hun ✓ 8-403, Hanyang Apt. 388-33 Ssangmun-Dong Dobong-Gu, Seoul 132-033, Republic of Korea			
State (that is, country) of nationality: KR		State (that is, country) of residence: KR	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) KIM, Sa Heum ✓ 138-1202 Hansung Mokhwa Apt. 880 Keumjung-Dong, Kunpo-City Kyungki-Do 435-050 Republic of Korea			
State (that is, country) of nationality: KR		State (that is, country) of residence: KR	
<input checked="" type="checkbox"/> Further applicants are indicated on a continuation sheet.			

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Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet should not be included in the demand.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

✓ KIM, Han Jun
231-25 Eungam-Dong, Eunpyoung-Gu
Seoul 122-012
Republic of Korea

State (that is, country) of nationality:

KR

State (that is, country) of residence:

KR

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

✓ HONG, Sung Min
104-1101 Oksoo Hights Apt.
Oksoo-Dong, Sungdong-Ku, Seoul 133-100
Republic of Korea

State (that is, country) of nationality:

KR

State (that is, country) of residence:

KR

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

State (that is, country) of nationality:

State (that is, country) of residence:

☐ Further applicants are indicated on another continuation sheet.

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Box No. III AGENT OR COMMON REPRESENTATIVE: OR ADDRESS FOR CORRESPONDENCEThe following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.Name and address: *(Family name followed by given name, for a legal entity, full official designation. The address must include postal code and name of country.)*SOHN, Chang Kyu; BAEK, Duk Yeul; LEE, Tae Hee
17th Floor, Marine Center Main Bldg., 118 Namdaemun-ro 2 ka
Chung-gu, Seoul 100-770
Republic of Korea

Telephone No.

82-2-772-4000

Facsimile No.:

82-2-772-4001

Teleprinter No.:

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:***

1. The applicant wishes the international preliminary examination to start on the basis of:

☐ the international application as originally filedthe description ☒ as originally filed☐ as amended under Article 34the claims ☒ as originally filed☐ as amended under Article 19 (together with any accompanying statement)☐ as amended under Article 34the drawings ☐ as originally filed☒ as amended under Article 342. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English

☐ which is the language in which the international application was filed.☐ which is the language of a translation furnished for the purposes of international search.☒ which is the language of publication of the international application.☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.**Box No. V ELECTION OF STATES**The applicant hereby elects all eligible States *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes not to elect:

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Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- | | |
|--|------------|
| 1. translation of international application | sheets |
| 2. amendments under Article 34 | 2 / sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | sheets |
| 4. copy (or, where required, translation) of statement under Article 19 | sheets |
| 5. letter | sheets |
| 6. other (specify) | sheets |

For International Preliminary Examining Authority use only

received	not received
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

The demand is also accompanied by the item(s) marked below:

- | | |
|--|---|
| 1. <input checked="" type="checkbox"/> fee calculation sheet | 4. <input type="checkbox"/> statement explaining lack of signature |
| 2. <input type="checkbox"/> separate signed power of attorney | 5. <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6. <input type="checkbox"/> other (specify): |

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

SOHN, Chang Kyu



BAEK, Duk Yeul



LEE, Tae Hee



For International Preliminary Examining Authority use only

- Date of actual receipt of DEMAND:
- Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):
- ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply.
 ☐ The applicant has been informed accordingly.
- ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.
- ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

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REC'D 26 APR 2001

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference FINE26(P)	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/KR99/00798	International filing date (day/month/year) 21 DECEMBER 1999 (21.12.1999)	Priority date (day/month/year) 22 DECEMBER 1998 (22.12.1998)
International Patent Classification (IPC) or national classification and IPC IPC7 H01M 10/36		
Applicant FINECELL Co., Ltd. et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

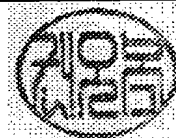
☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability, citations and explanations supporting such statement
- VI ☒ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 03 APRIL 2000 (03.04.2000)	Date of completion of this report 13 APRIL 2001 (13.04.2001)
Name and mailing address of the IPEA/KR Korean Intellectual Property Office Government Complex-Taejon, Dunsan-dong, So-ku, Taejon Metropolitan City 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer KWON, Oh Bok Telephone No. 82-42-481-5994



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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/KR99/00798

I. Basis of the report

1. With regard to the elements of the international application:*

- ☒ the international application as originally filed
- ☐ the description:
 pages _____, as originally filed
 pages _____, filed with the demand
 pages _____, filed with the letter of _____
- ☐ the claims:
 pages _____, as originally filed
 pages _____, as amended (together with any statement) under Article 19
 pages _____, filed with the demand
 pages _____, filed with the letter of _____
- ☐ the drawings:
 pages _____, as originally filed
 pages _____, filed with the demand
 pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
 pages _____, as originally filed
 pages _____, filed with the demand
 pages _____, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language English which is

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet _____

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed." and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

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INTERNATIONAL PRELIMINARY EXAMINATION

International application No.

PCT/KR99/00798

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-7	YES
	Claims		NO
Inventive step (IS)	Claims	1-7	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-7	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Reference is made to the following documents :

D1 : US-A-5079109

D2 : 'Development of Film-Like Lithium Battery Using Solid Polymer Electrolyte' In : Telecommunications Energy Conference, 1995

1. D1 discloses a nonaqueous electrolyte prepared by dissolving an electrolyte salt in a solvent mixture consisting of ethylene carbonate, 2-methylhydrofuran, and subjected to a treatment of bringing said composition in contact with an insoluble absorbent, but does not disclose an electrolyte film having a thickness of 10 to 0.2 mm and microporous structures.

D2 discloses electrolyte film but does not disclose an ion conductive liquid electrolyte and an absorbent contained in electrolyte film.

Accordingly the subject-matter of claims 1 and 7 seems to be novel(Article 3(2) PCT).

2. Neither D1 nor D2 suggests an electrolyte film having a microporous structures.

Thus claims 1 and 7 also involve an inventive step and meet the requirement of Article 33(3) PCT.

3. Claims 2-6 also comply with Article 33(2) and (3) PCT as they are dependent claims.

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INTERNATIONAL PRELIMINARY EXAMINATION

International application No.

PCT/KR99/00798

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date (day/month/year)	Filing date (day/month/year)	Priority date (valid claim) (day/month/year)
US-A-5079109	07/01/92	15/05/90	16/05/89

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure (day/month/year)	Date of written disclosure referring to non-written disclosure (day/month/year)

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[별지 제65호의49서식]

보 정 제 출 서

(Submission of Amendments under Article 34)

국제출원번호		PCT/KR99/ 00798	국제출원일	1999.12.21.	우 선 일	1998.12.22.
출 원 인	성 명	주식회사 파인셀의 3인	주민등록번호		국 적	
	주 소	경기도 성남시 분당구 야탑동 150 아파트형공장 가동 407호				
대 리 인	성 명	손 창 규 백 덕 열 이 태 희	대리인코드	9-1998-000300-9 9-1998-000217-2 9-1998-000323-2	전화번호	02) 772-4000
	주 소	서울시 중구 남대문로 2가 118 해운센터빌딩본관 19층				

- ☐ 특허법시행규칙 제106조의33제2항의 규정에 의하여 위와 같이 제출합니다.
☒ 특허법시행규칙 제106조의36제3항의 규정에 의하여 위와 같이 제출합니다.

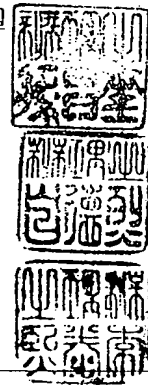
2000 년 3 월 30 일

대리인 변리사 손 창 규

대리인 변리사 백 덕 열

대리인 변리사 이 태 희

특 허 칭 장 귀 하



※ 첨부서류

1. 영어로 작성된 보정서 2통

7. 000000

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Statement of Amendment to the Drawings

PCT/KR99/00798

International Filing Date: 21 December 1999 (21. 12. 99)

Priority Date: 22 December 1998 (22. 12. 98)

Agent's File Reference: FINE26(P)

Title of the Invention: Solid Electrolytes Using Absorbent And Methods For Preparing Them

Two drawings in the present international application are replaced with the new ones. When we filed the present international application with the Korean Industrial Property Office as a receiving office, we attached the drawings of PCT/KR99/00797 thereto by a clerical error.

This amendment to the drawings is supported by the certified priority document submitted on January 24, 2000 and the detailed description, especially Table 3 on Page 35 of the present international application.

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(Amendments)

DRAWINGS

Fig. 1

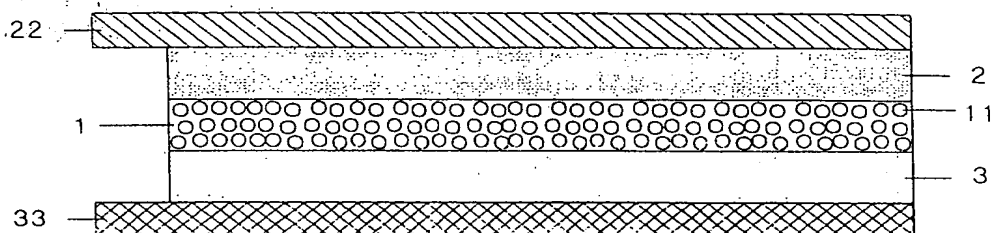
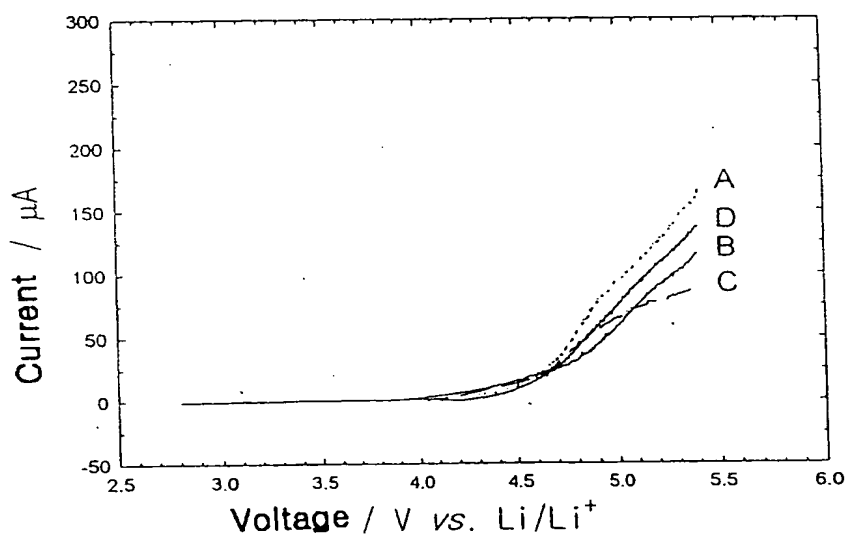


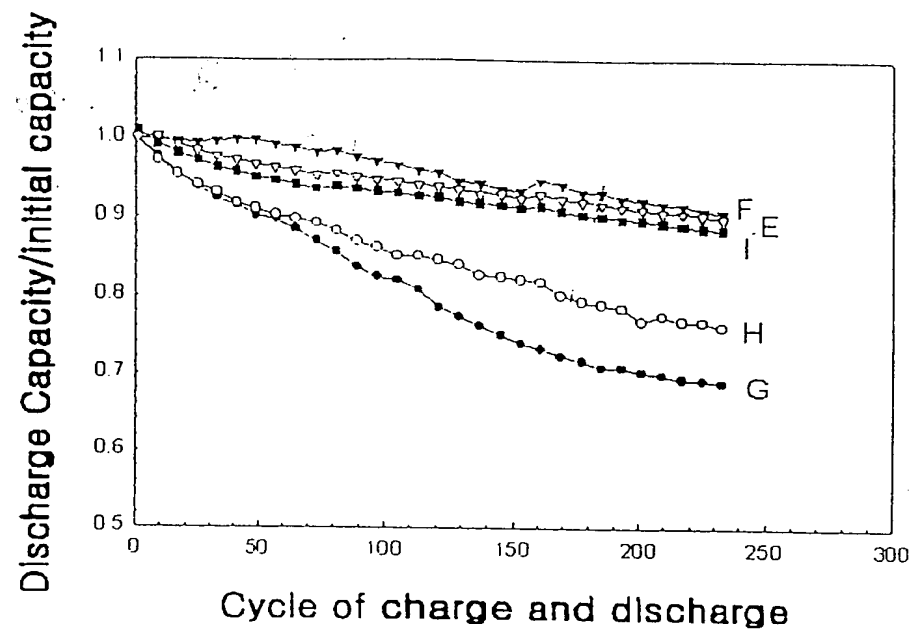
Fig. 2



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Fig. 3



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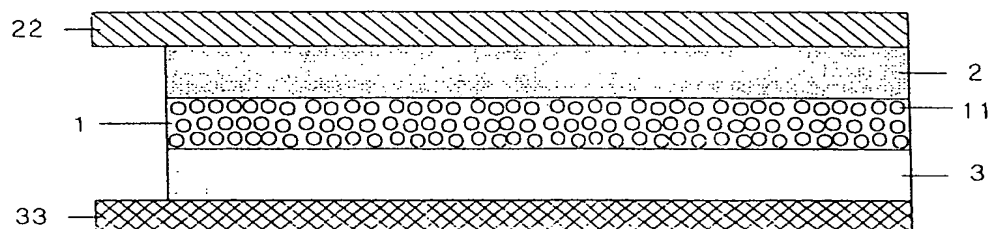
JC18 Rec'd PCT/PTO 1 5 JUN 2001

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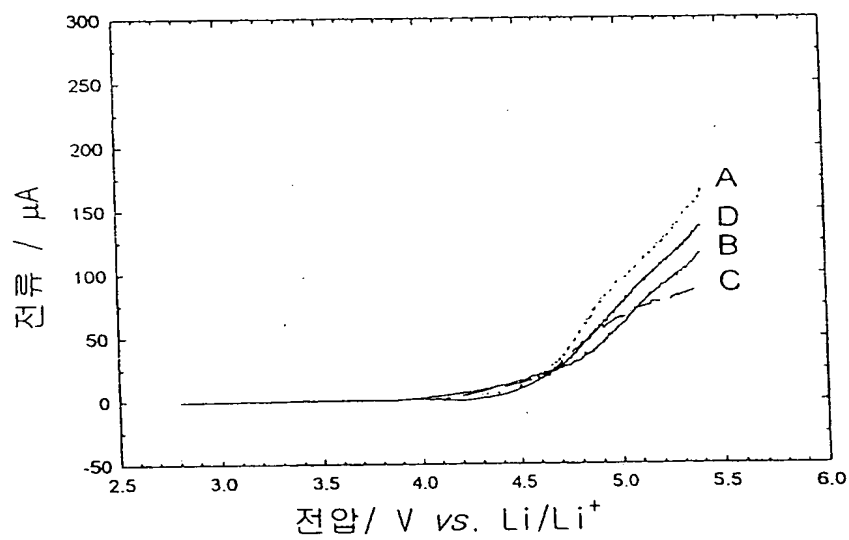
(Drawings in Priority KR Application No. 1998/57031: Dec. 22, 1998)

【도면】

【도 1】



【도 2】

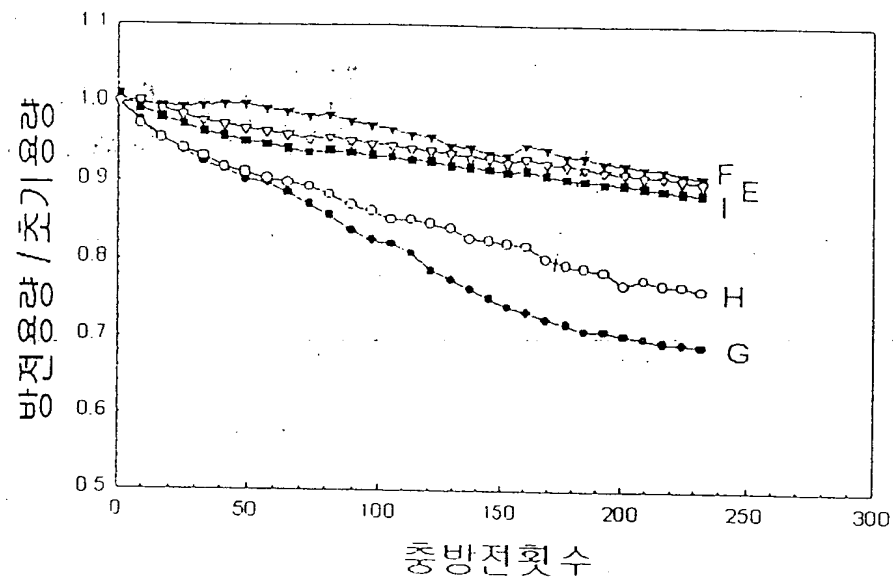


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JC18 Rec'd PCT/PTO 1 5 JUN 2001

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【도 3】



JC18 Rec'd PCT/PTO 1 5 JUN 2001

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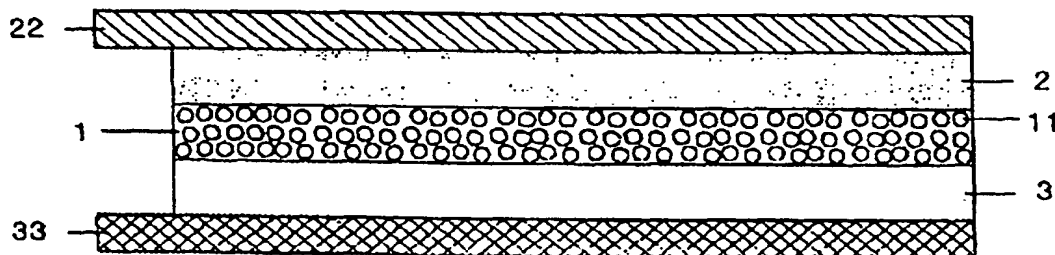
PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H01M 10/36	A1	(11) International Publication Number: WO 00/38263 (43) International Publication Date: 29 June 2000 (29.06.00)
(21) International Application Number: PCT/KR99/00798 (22) International Filing Date: 21 December 1999 (21.12.99) (30) Priority Data: 1998/57031 22 December 1998 (22.12.98) KR (71) Applicant (for all designated States except US): FINECELL CO., LTD. [KR/KR]; Room No. Ka-Dong 407, Factory Apartment, 150 Yatap-Dong, Pundang-Gu, Sungnam-City, Kyungki-do 463-070 (KR). (71)(72) Applicants and Inventors: JANG, Dong, Hun [KR/KR]; 8-403 Hanyang Apt., 388-33 Ssangmun-Dong, Dobong-Gu, Seoul 132-033 (KR). KIM, Sa, Heum [KR/KR]; 138-1202 Hansung Mokhwa Apt., 880 Keumjung-Dong, Kunpo-City, Kyungki-Do 435-050 (KR). KIM, Han, Jun [KR/KR]; 231-25 Eungam-Dong, Eunpyoung-Gu, Seoul 122-012 (KR). (72) Inventor; and (75) Inventor/Applicant (for US only): HONG, Sung, Min [KR/KR]; 104-1101 Oksoo Hights Apt., Oksoo-Dong, Sungdong-Ku, Seoul 133-100 (KR).		(74) Agents: SOHN, Chang, Kyu et al.; 17th floor, Marine Center Main Building, 118 Namdaemun-ro 2-ka, Chung-ku, Seoul 100-770 (KR). (81) Designated States: CN, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i> <i>In English translation (filed in Korean).</i>

(54) Title: MICROPOROUS SOLID ELECTROLYTES AND METHODS FOR PREPARING THEM



(57) Abstract

The present invention relates to a solid electrolyte having a good conductivity to lithium ion by allowing the liquid components and lithium salts to be absorbed into the electrolyte film containing an absorbent added at the time of its preparation and having a porosity, a process for preparing the same and a rechargeable lithium cell using the same as an electrolyte. As the absorbent, inorganic materials having not more than 40 μm of particle size can be used. As the polymer binder, any binder of whom solubility against the liquid electrolyte is small can be used. A wet process can introduce the porous structure of the electrolyte film. The solid electrolyte according to the present invention has the ionic conductivity of more than approximately 1 to 3 $\times 10^{-3}$ S/cm at room temperature and low reactivity to lithium metal. The cell is fabricated from the solid electrolyte together with electrodes by lamination or pressing methods and, the liquid electrolyte, which is decomposed by moisture, is introduced to a cell just before packaging. Therefore, the solid electrolyte according to the present invention is not affected by the humidity and temperature conditions during the manufacturing of the electrolyte film. In addition, the solid electrolyte according to the present invention has high thermal, mechanical and electrochemical stability, and thus is suitable as an electrolyte for rechargeable lithium cells.

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Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
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CM	Cameroon			PL	Poland		
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DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR99/00798

A. CLASSIFICATION OF SUBJECT MATTER IPC7 H01M 10/36 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC7 H01M Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean Patents and applications for inventions since 1975 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) IEL(IEEE/IEE Electronic Library), Since 1988, solid <and> electrolyte <and> lithium		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,079,109 A (TOSHIBA BATTERY CO), 7 January 1992, See abstract	4
A	YASUMASA NAKAJIMA, YUICHI AIHARA, SIRO KATO and KAZUO MURATA 'Development of Film-like Lithium Battery Using Solid Polymer Electrolyte' In: Telecommunications Energy Conference, 1995. INTELEC '95., 17th International Published: 1995, Page(s): 704 - 709 See Fig. 4	1-7
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 30 MARCH 2000 (30.03.2000)		Date of mailing of the international search report 31 MARCH 2000 (31.03.2000)
Name and mailing address of the ISA/KR Korean Industrial Property Office Government Complex-Taejon, Dunsan-dong, So-ku, Taejon Metropolitan City 302-701, Republic of Korea Facsimile No. 82-42-472-7140		Authorized officer KWON, Oh Bok Telephone No. 82-42-481-5994



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